※ 考生請注意：本試題不可使用計算機

1. Consider a difference equation as the following:

$$y(k)-0.2y(k-1)-0.64y(k-2)+0.128y(k-3)=5x(k)+4x(k-1)$$

Please calculate the transfer function and determine if this system is BIBO stable? Please explain why this transfer function is stable or unstable? (20%)

2. (i) Find the steady-state errors e_{ss} for the system in Figure 1 with different inputs $r(t)=5u(t)$, $r(t)=5tu(t)$, and $r(t)=5t^2u(t)$. (10%)

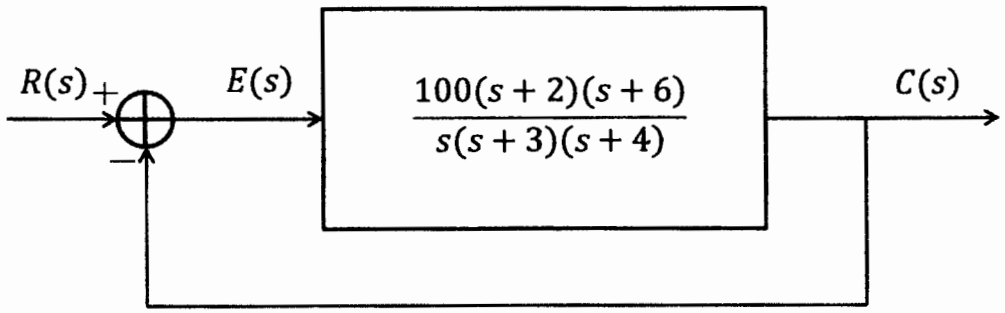

Figure.1

where $u(t)$ is the unit step function, $R(s)$, $C(s)$ and $E(s)$ are Laplace Transforms of input signal, output signal and error between input and output.

(ii) Find the steady-state errors e_{ss} of system in Figures 2 with respect to the input $r(t)=10u(t)$, and $u(t)$, $R(s)$, $C(s)$ and $E(s)$ are defined as that in (i). (5%)

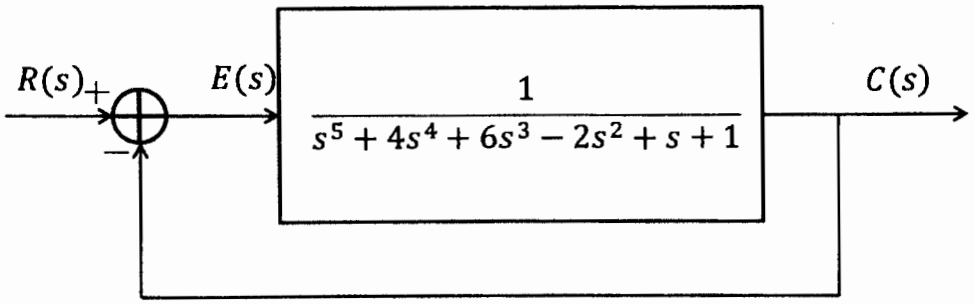

Figure 2

(背面仍有題目,請繼續作答)

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3. Consider a controller as shown in Figure 3. Please find the transfer function $V_o(s)/V_i(s)$ of the controller. (b) Calculate the control output $v_o(t)$ of the circuit in Figure 3 with circuit parameters $R_1 = 100\text{K}\Omega$, $R_2 = 50\text{K}\Omega$, $C_1 = 30\mu F$, $C_2 = 60\mu F$ and input voltage $v_i(t) = 5\text{V}$. (20%)

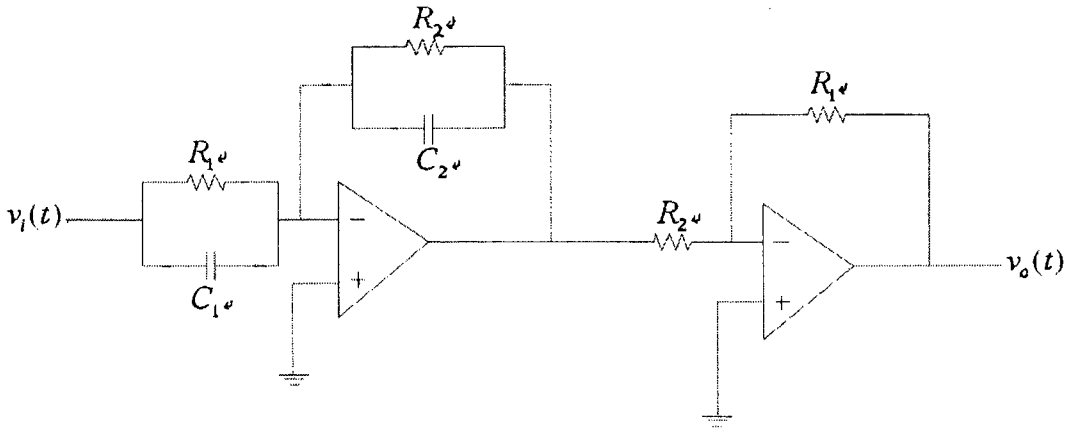

Figure 3

4. (i) According to the system as shown in Figure 4, please derive the expression of error $E(s)$. (15%)

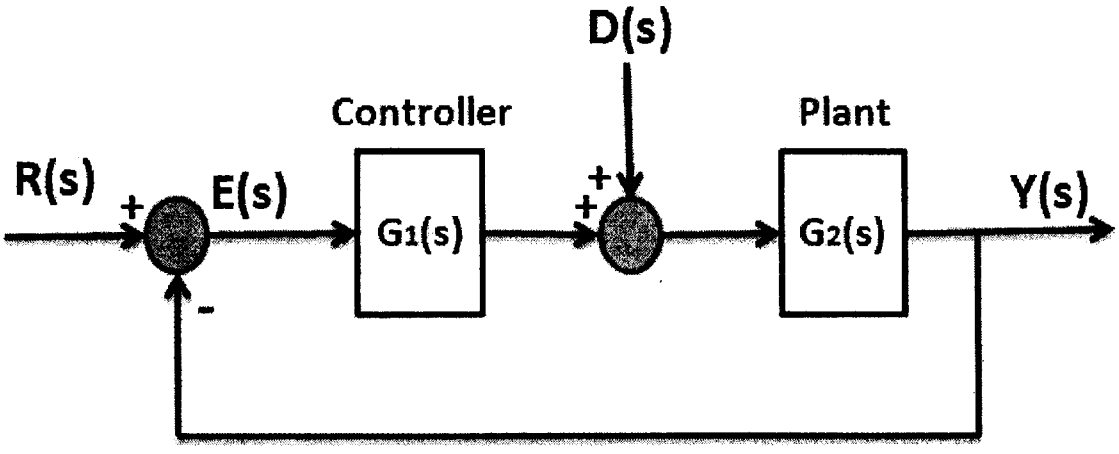

Figure 4

(ii) Suppose $G_1(s) = 1000$ and $G_2(s) = \dfrac{s+2}{s+4}$, and please express the steady-state error e_{ss} due to a ramp input $R(s)$ and a unit step disturbance $D(s)$ for the system in Figure 4. (5%)

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5. The dynamic equation of a system is given as below.

(a) Determine whether the system is controllable and observable. (5%)

(b) Design a state feedback law $u=-kX$ which generates a closed-loop system with eigenvalues -1, -3 -4. (10%)

$$\dot{X}=\begin{bmatrix}-1 & 0 & 3\\ 2 & -1 & -1\\ -3 & 1 & -2\end{bmatrix}X+\begin{bmatrix}1\\0\\0\end{bmatrix}u,\quad y=\begin{bmatrix}1 & 2 & 1\end{bmatrix}X$$

6. Consider the differential equation $\frac{d^2x}{dt^2}+3\frac{dx}{dt}+2x=f(x)$ where $f(x)$ is the input and is a function of x. If $f(x)=\sin x$, linearize the differential equation for small excursions. (10%)

(a) $x=0$

(b) $x=\pi$